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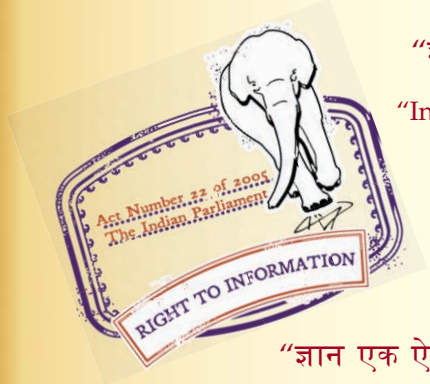
IS 8841 (1978): Recommendations for limits and fits for sizes above 3 150 mm upto 10 000 mm [PGD 20: Engineering Standards]



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"Knowledge is such a treasure which cannot be stolen"

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UDC 621·753·2 (First Reprint AUGUST 1988) IS : 8844 - 1978

Indian Standard

RECOMMENDATIONS FOR LIMITS AND FITS FOR SIZES ABOVE 3 150 mm UP TO 10 000 mm

(Reaffirmed 2003)

Engineering Metrology Sectional Committee, EDC 43; Limits and Fits Subcommittee, EDC 43 : 1 [Ref : Doc : EDC 43 (2704)]

1. Scope — This standard makes recommendations relating to tolerances, limits and fits for sizes above 3 150 mm up to 10 000 mm.

2. Terminology — Definitions given in IS : 919-1963 'Recommendations for limits and fits for engineering (*first revision*) ', shall apply.

3. Tolerances

3.1 Sixteen grades of tolerances are provided with designations IT 1 to IT 16. For these grades, the tolerance values have been determined in terms of the standard tolerance unit i as follows:

$$i \text{ (in } \mu m) = 0{\cdot}004\, D + 2{\cdot}1$$

where D is the geometric mean of the extreme diameters in each diameter step as explained in **3.2**.

3.1.1 The values of the standard tolerances corresponding to grades 1 to 16 in terms of the tolerance unit i shall be as given below:

IT 1	IT 2	IT 3	IT 4	IT 5	IT 6	IT 7	IT 8	IT 9	IT 10	IT 11	IT 12	IT 13	IT 14	IT 15	IT 16
1·5i	2·5i	3·6i	5i	7i	10i	16i	25i	40i	64i	100i	160i	250i	400i	640i	1000i

3.2 Diameter steps have been given in Table 1, for the sake of simplicity, the formula given in **3.1** for the calculation of standard tolerance and the formula given in Table 2 for the calculation of fundamental deviations have been applied to suit the diameter steps given in Table 1. The results have been computed based on the geometric mean, D of the extreme diameters of each step and apply to all diameters of this step.

3.3 Table 3 gives, for each diameter step, the values of standard tolerances for grades 1 to 16 on the basis of the formula given in **3.1**. IT 1 to IT 5 are meant for production of gauges and similar comparative measuring instruments, IT 6 to IT 11 are for assembly fits and IT 12 to IT 16, for coarser tolerance.

TABLE 1 DIAMETER STEPS IN mm

(*Clause* 3.2)

General Cases		Special Subdivisions	
Above	Up to	Above	Up to
3 150	4 000,	3 150	3 550
		3 550	4 000
4 000	5 000	4 000	4 500
		4 500	5 000
5 000	6 300	5 000	5 600
		5 600	6 300
6 300	8 000	6 300	7 100
		7 100	8 000
8 000	10 000	8 000	9 000
		9 000	10 000

Adopted 12 June 1978 Gr 5

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TABLE 2 FORMULAE FOR SHAFT AND HOLE DEVIATIONS

(*Clauses* 3.2, 4.1 *and* 4.2.1)

Shaft	Deviations		Formulae for Deviations in μm (for D in mm)	Deviations		Holes
d	es	−	$16\ D^{0.44}$	+	EI	D
e	es	−	$11\ D^{0.41}$	+	EI	E
f	es	−	$5.5\ D^{0.41}$	+	EI	F
g	es	−	$2.5\ D^{0.34}$	+	EI	G
h	es		0		EI	H
Js	ei	−	0·5 IT	+	ES	Js
k	ei		0		ES	K
n	ei	+	$0.04\ D + 21$	−	ES	N
p	ei	+	$0.072\ D + 37.8$	−	ES	P
r	ei	+	Geometric mean of values between *p* and *s* or *P* and *S*	−	ES	R
s	ei	+	IT 7 + 0·4 *D*	−	ES	S
t	ei	+	IT 7 + 0·63 *D*	−	ES	T
u	ei	+	IT 7 + *D*	−	ES	U

4. Deviations

4.1 For each symbol, the magnitude and sign of one of the two deviations namely the fundamental deviation (upper deviation ' es ' and ' ES ' or lower deviation ' ei ' and ' EI ') shall be determined by the formulae given in Table 2. The deviation given by the formulae in Table 2 is in principle that corresponding to the limits closest to the zero line, that is the upper deviation ' es ' for shafts d to h and the lower deviation ' ei ' for shafts k to u, or the lower deviation ' EI ' for holes D to H and upper deviation ' ES ' for holes P to U.

4.2 The other deviations may be derived using the absolute value of the IT tolerance, by means of the follcwing algebraic relationships:

$$ei = es - IT$$

or

$$es = ei + IT$$

$$EI = ES - IT$$

or

$$ES = EI + IT$$

4.2.1 The rounded values for these deviations calculated on the basis of Tables 2 and 3 are given in Tables 4 and 5.

4.3 Tables 6 and 7 give the limits for commonly used holes and shafts.

4.4 A display of tolerance zones for shafts in the diameter range of 6 300 to 8 000 mm is shown in Fig. 1, and the disposition of preferred shafts with respect to hole H8 in the diameter range of 6 300 to 8 000 mm is shown in Fig. 2.

TABLE 3 STANDARD TOLERANCES OF GRADES 1 TO 16

(*Clauses* 3.3 *and* 4.2.1)

Diameter Steps in mm		IT Grades															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Above	Up to	Values in μm															
3 100	4 000	24	41	58	80	115	165	260	410	660	1 050	1 650	2 600	4 100	6 600	10 500	16 500
4 000	5 000	30	50	70	100	140	200	320	500	800	1 300	2 000	3 200	5 000	8 000	13 000	20 000
5 000	6 300	39	62	88	120	170	250	400	620	980	1 550	2 500	4 000	6 200	9 800	15 500	25 000
6 300	8 000	46	75	110	130	210	310	490	760	1 200	1 950	3 100	4 900	7 600	12 000	19 500	31 000
8 000	10 000	56	95	135	190	270	380	600	920	1 500	2 400	3 800	6 000	9 200	15 000	24 000	38 000

Note — Numerical values of tolerances are rounded as follows; up to 50, as a whole number; from 50 to 100, as an even number (number 5 is not rounded); from 100 to 200, to the nearest 5's; from 200 to 500, to the nearest 10's; from 500 to 1 000, to the nearest 20's; from 1 000 to 2 000, to the nearest 50's; from 2 000 to 5 000, to the nearest 100's; from 5 000 to 10 000, to the nearest 200's; and above 10 000, to the nearest 500's.

TABLE 4 FUNDAMENTAL DEVIATIONS FOR HOLES

(*Clause* 4.2.1)

(1 μm = 0·001 mm)

Fundamental Deviations in μm												
Deviation Steps in mm		Lower Deviation (EI)						Upper Deviation (ES)				
		D	E	F	G	H	Js	K	N	P	R	S
Above	Up to	Grades IT 6 to IT 16										
3 150	3 550	+580	+320	+160	+40	0	Deviation = ± IT/2	0	−165	−290	−680	−1 550
3 550	4 000										−720	−1 750
4 000	4 500	+640	+350	+175	+44	0		0	−200	−360	−840	−2 000
4 500	5 000										−900	−2 200
5 000	5 600	+720	+380	+190	+48	0		0	−250	−450	−1 050	−2 500
5 600	6 300										−1 150	−2 800
6 300	7 100	+800	+420	+210	+52	0		0	−310	−560	−1 300	−3 100
7 100	8 000										−1 400	−3 500
8 000	9 000	+880	+460	+230	+56	0		0	−380	−680	−1 650	−4 000
9 000	10 000										−1 750	−4 400

TABLE 5 FUNDAMENTAL DEVIATIONS FOR SHAFTS

(*Clause* 4.2.1)

(1 μm = 0·001 mm)

Fundamental Deviations in μm												
Deviation Steps in mm		Upper Deviation (es)						Lower Deviation (ei)				
		d	e	f	g	h	js	k	n	p	r	s
Above	Up to	Grades IT 6 to IT 16										
3 150	3 550	−580	−350	−160	−40	0	Deviation = ± IT/2	0	+165	+290	+680	+1 550
3 550	4 000										+720	+1 750
4 000	4 500	−640	−350	−175	−44	0		0	+200	+360	+840	+2 000
4 500	5 000										+900	+2 200
5 000	5 600	−720	−380	−190	−48	0		0	+250	+450	+1 050	+2 500
5 600	6 300										+1 150	+2 800
6 300	7 100	−800	−420	−210	−52	0		0	+310	+560	+1 300	+3 100
7 100	8 000										+1 400	+3 500
8 000	9 000	−880	−460	−230	−56	0		0	+380	+680	+1 650	+4 000
9 000	10 000										+1 750	+4 400

TABLE 6 LIMITS FOR HOLES

(*Clause* 4.3)

(1 μm = 0·001 mm)

Diameter Steps in mm		Values of Deviations in μm					
Above	Up to	H7	H8*	H9	H10	H11	H12
3 150	4 000	+260 0	+410 0	+660 0	+1 050 0	+1 650 0	+2 600 0
4 000	5 000	+320 0	+500 0	+800 0	+1 300 0	+2 000 0	+3 200 0
5 000	6 500	+400 0	+620 0	+980 0	+1 550 0	+2 500 0	+4 000 0
6 300	8 000	+490 0	+760 0	+1 200 0	+1 950 0	+3100 0	+4 900 0
8 000	10 000	+600 0	+920 0	+1 500 0	+2 400 0	+300 0	+6 000 0

Note 1 — H7 is used only for special cases which demand high accuracy.

Note 2 — Because of the considerable difference between H8 and H11, it is possible to use holes H9 and H10 in cases where H8 is too accurate and H11 is too coarse.

Note 3 — H12 is not recommended for fits.

*Recommended holes.

TABLE 7 LIMITS FOR SHAFTS

(*Clause* 4.3)

(1 μm = 0·001 mm)

Diameter Steps in mm		Values of Deviations in μm												
Above	Up to	d9	d10*	d11	e8*	e9*	e10	f7	f8*	f9	f10	g6	g7	g8
3 150	4 000	−580 −1 240	−580 −1 630	−580 −2 230	−320 −730	−320 −980	−320 −1 370	−160 −420	−160 −570	−160 −820	−160 −1 210	−40 −205	−40 −300	−40 −450
4 000	5 000	−640 −1 440	−640 −1 940	−640 −2 640	−350 −850	−350 −1 150	−350 −1 650	−175 −495	−175 −675	−175 −975	−175 −1 475	−44 −244	−44 −364	−44 −544
5 000	6 300	−720 −1 700	−720 −2 270	−720 −3 220	−380 −1 000	−380 −1 360	−380 −1 930	−190 −590	−190 −810	−190 −1 170	−190 −1 740	−48 −298	−48 −448	−48 −658
6 300	8 000	−800 −2 000	−800 −2 750	−800 −3 900	−420 −1 180	−420 −1 620	−420 −2 370	−210 −700	−210 −970	−210 −1 410	−210 −2 160	−52 −352	−52 −542	−52 −812
8 000	10 000	−880 −2 380	−880 −3 280	−880 −4 680	−460 −1 380	−460 −1 960	−460 −2 860	−230 −830	−230 −1 150	−230 −1 730	−230 −2 630	−56 −436	−56 −656	−56 −976

*Preferred shafts.

(*Continued*)

TABLE 7 LIMITS FOR SHAFTS — *Contd*

(1 μm = 0·001 mm)

Diameter Steps in mm		Values of Deviations in μm													
Above	Up to	h7	h8	h9	h10	h11	h12	js7	js8	js9	k7	k8	n7	n8	p7	p8
3 150	4 000	0 −260	0 −410	0 −660	0 −1 050	0 −1 650	0 −2 600	+130 −130	+205 −205	+330 −330	+260 0	+410 0	+425 +165	+575 +165	+550 +290	+700 +290
4 000	5 000	0 −320	0 −550	0 −800	0 −1 300	0 −2 000	0 −3 200	+160 −160	+250 −250	+400 −400	+320 0	+500 0	+520 +200	+700 +200	+680 +360	+860 +360
5 000	6 300	0 −400	0 −620	0 −980	0 −1 550	0 −2 500	0 −4 000	+200 −200	+310 −310	+590 −590	+400 0	+620 0	+630 +250	+870 +250	+850 +450	+1 070 +450
6 300	8 000	0 −490	0 −760	0 −1 200	0 −1 950	0 −3 100	0 −4 900	+245 −245	+380 −380	+600 −600	+490 0	+760 0	+800 +310	+1 070 +310	+1 050 +560	+1 320 +560
8 000	10 000	0 −600	0 −920	0 −1 500	0 −2 400	0 −3 800	0 −6 000	+300 −300	+460 −460	+750 −750	+600 0	+920 0	+980 +380	+1 300 +380	+1 280 +680	+1 600 +680

Note — Shaft h12 is not recommended for fits.

(*Continued*)

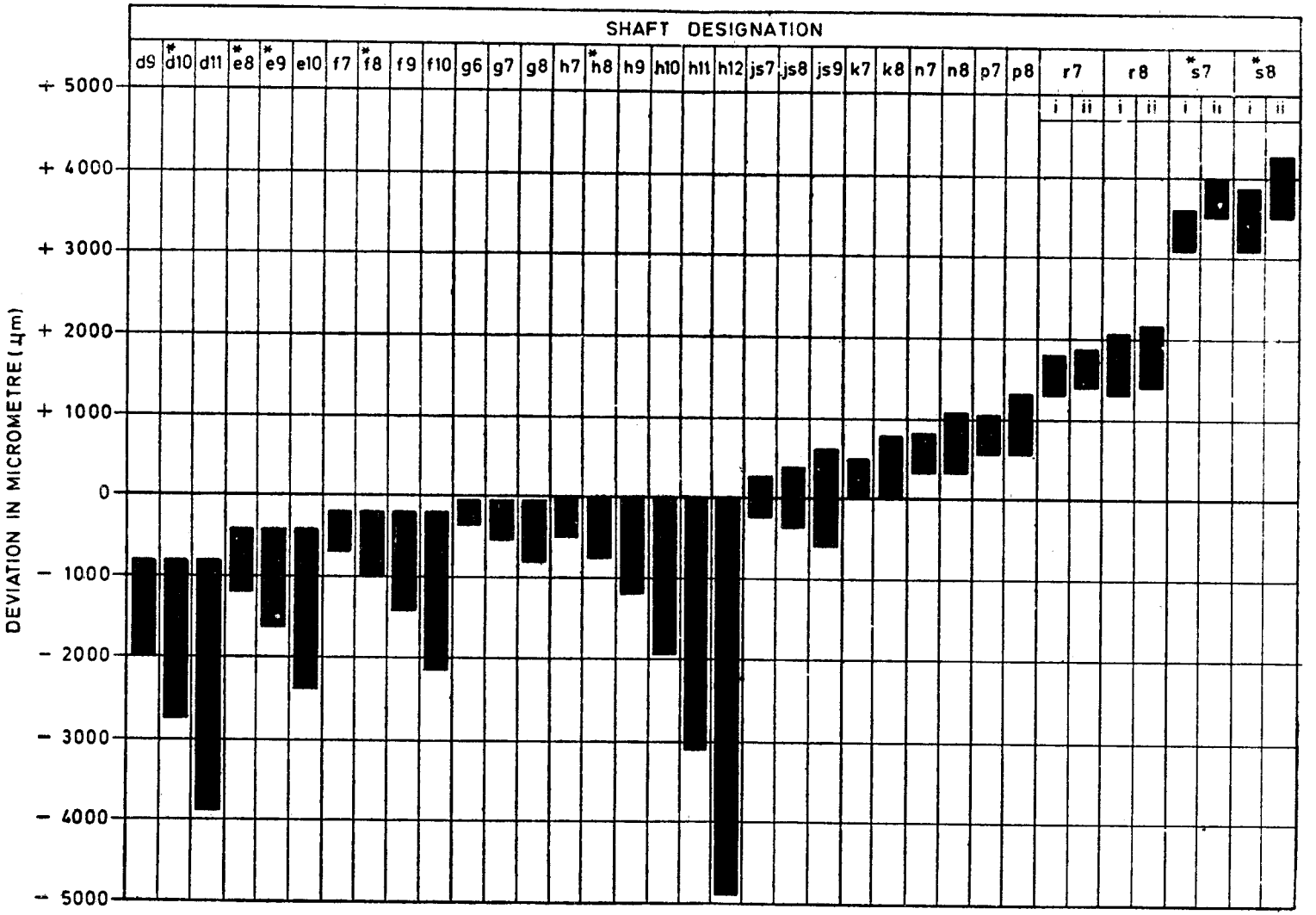
TABLE 7 LIMITS FOR SHAFTS — *Contd*

(*Clause* 4.3)

(1 μm = 0·001 mm)

Values of Deviations in μm					
Diameter Steps in mm		**r7**	**r6**	**s7***	**s8***
Above	Up to				
3 150	3 550	+940 +680	+1 090 +680	+1 810 +1 550	+1 960 +1 550
3 550	4 000	+980 +720	+1 130 +720	+2 010 +1 750	+2 160 +1 750
4 000	4 500	+1 160 +840	+1 340 +840	+2 320 +2 000	+2 500 +2 000
4 500	5 000	+1 220 +900	+1 400 +900	+2 520 +2 200	+2 700 +2 200
5 000	5 600	+1 450 +1 050	+1 670 +1 050	+2 900 +2 500	+3 120 +2 500
5 600	6 300	+1 550 +1 150	+1 770 +1 150	+3 200 +2 800	+3 420 +2 800
6 300	7 100	+1 790 +1 300	+2 060 +1 300	+3 590 +3 100	+3 860 +3 100
7 100	8 000	+1 890 +1 400	+2 160 +1 400	+3 990 +3 500	+4 260 +3 500
8 000	9 000	+2 250 +1 650	+2 570 +1 650	+4 600 +4 000	+4 920 +4 000
9 000	10 000	+2 350 +1 750	+2 670 +1 750	+5 000 +4 400	+5 320 +4 400

*Preferred shafts.



Note — In case of shafts r and s

'*i*' stands for diameter range 6 300 to 7 100 mm, and

'*ii*' stands for diameter range 7 100 to 8 000 mm.

*Preferred shafts.

FIG. 1 TOLERANCE ZONES FOR SHAFTS IN DIAMETER RANGE OVER 6 300 TO 8 000 mm

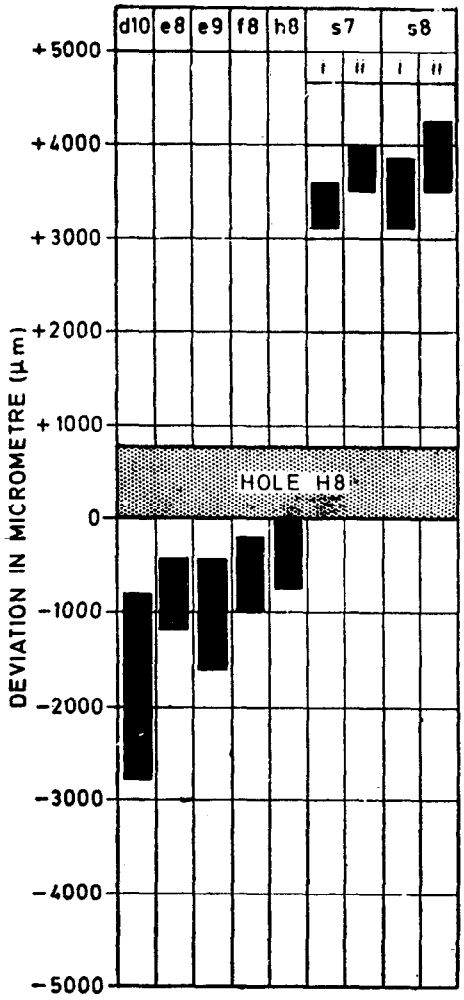


FIG. 2 TOLERANCE ZONES FOR PREFERRED SHAFTS WITH RESPECT TO HOLE H8 IN DIAMETER RANGE OVER 6 300 TO 8 000 mm

EXPLANATORY NOTE

This standard relates to tolerances, limits and fits for large diameters and is a supplement to IS : 919-1963 'Recommendations for limits and fits for engineering (*revised*)', and IS : 2101-1962 'Recommendations for limits and fits for sizes above 500 mm up to 3 150 mm' which give the recommendations for sizes up to 500 mm and 3 150 mm respectively.

It is difficult to ascertain accurately the error of measurement involved in gauging large sizes but generally it is considered that:

a) the accuracy of absolute measurement that can be expected from the modern engineering shop under normal conditions is not better than ± 30 μm per metre,

b) the accuracy of absolute measurement that can be expected from the modern engineering shop with very accurate equipment and considerable experience in such measurements is not better than ±15 μm per metre, and

c) the accuracy of comparison of size that can be expected from the modern engineering shop under normal conditions is not better than ±15 μm per metre.

The practical effect of error of measurement becomes appreciable when the parts are toleranced without introducing the compensation for this error. However, this error need be compensating only if the deviation reduces its original value by more than 20 percent, for example, if the deviation is 450 μm/m, then since the reduction due to error of measurement will be at the most 60 μm/m (which is less than 20 percent of 450), no compensation for the error need be made.

In the preparation of this draft standard, assistance has been derived from:

a) CSN 014204 System of limits and fits for sizes above 500 up to 10 000 mm, issued by Urad pro normalizaci a merenil, Czechoslovakia.

b) GOST 2689-1954 Tolerances and fits for dimensions from 500 to 10 000 mm, issued by Gosudarstvennyj Komited Standartov, USSR.

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